WORKING PAPER NO. 87

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Energy sources, being the essential requirement for economic development, have played and will continue to play a decisive role in the development of human society and its welfare. Energy is a crucial input not only for agricultural and industrial development but also a positive source of scientific and technological innovations. Only adequate production and supplies of fuel, thermal and electrical energy can secure to day scientific and technical progress in all spheres of human activity and meet man's vital needs.

Presently the world produces and consumes over 9000 million tonnes of equivalent fuel every year. The production and consumption of electricity is about 9,000,000 million kwh per annum and these volumes are expected to increase in the future. By the year 2025, the earth's population is likely to be 8 billion people - twice of today's 4 billion. Over 80 per cent of this number will live in presently developing countries of Asia, Africa and Latin America. Energy supplies must grow more rapidly than population in order to raise the quality and the quantity of human diets, increase in incomes and employment opportunities. Basically, energy is required

by three key sectors of the economy, namely, agriculture, industry and households. Energy consumptions varies from region to region, country to country. In industrially developed countries, energy consumption per capita exceeds many times that of the developing nations. World energy supplies can be considerably increased through the use of renewable sources of energy such as, solar, wind, bio-mass, geothermal, tides, etc.

There are many problems related to energy production, consumption and transportation. An extraction of fuel and its transportation continue to become costlier and energy transportation processes are more sophisticated. The development and the exploitation of fuel and energy sources need increased labour inputs more capital investments, extensive research and new technological devices. It is assumed that the relative share of oil in the world energy consumption will gradually decrease and that of coal, gas and atomic energy will increase. The energy scene in the twentieth century both has been and will continue to be characterised by change. There have been basic changes in both the level and pattern of world energy production and consumption. The energy needs of society depends not only on the volume of materials produced, but also on how rationally and economically used and conserved. The growing importance of human society is attached to the fuel and energy issue. The 12th Congress of World Energy Conference held in New Delhi on

19-23 September 1983 observed that energy is essential for human existence and progress, its indiscriminate use could lead to negative and harmful impact which might adversely affect the quality of life.

In India, the main sources of commercial energy supplies are coal, hydro and nuclear power, and the commercial sources of energy account about 60 per cent of the total energy consumption. The total commercial energy consumption in India increased five-fold during the last 25 years. A little over 40 per cent of the energy requirements of the economy are still met from non-commercial sources, namely firewood, agricultural and animal wastes. The non-conventional source of energy can be divided into two broad categories: (i) Animate energy sources; and (ii) Bio-mass and related sources. The first category includes draft power and human labour which are important sources of energy in the Third World agriculture, providing upto 90 per cent of all energy used in traditional agricultural systems. The second category includes bio-mass and related sources such as wood fuel, shrubs, charcoal, sawdust, crop residues and animal wastes.

The household sector is the largest consumer of energy which accounts for about 50 per cent of the total energy consumption in the country. Cooking and lighting are the main purposes of energy requirement in household sector and a bulk of energy consumption is required for cooking. The population of our country is about 720 million and the number

of households is around 145 million comprising of 114 million residing in the rural areas. It is assumed that at least 145 million cooking fires are lit at least twice in every day. With the present rate of population growth the number of households in the country is expected to increase to about 180 million by the end of this century. The import of crude oil and other pertroproducts require over 70 per cent of our foreign exchange earnings. In order to achieve self-sufficiency in energy, a timely and sustained effort is needed, mainly in two directions viz., in augmenting idigenous conventional energy sources, such as coal, oil, hydro and nuclear energy and developing rapidly new and renewable sources of energy such as bio-mass, wind, water, solar, etc. The use of bio-mass such as, agricultural wastes, animal dung and energy plantation as a source of energy needs greater popularisation in both rural and urban areas. The pattern of energy consumption and conservation and their related problems in rural areas are different in nature. In rural areas, the most of the energy consumed comes from non-commercial sources and most of the energy is consumed by domestic sector for cooking purposes. Due to degradation of forests, not only the problem of fuel wood has become severe but also the problem of environmental and ecological inbalances has emerged. The nutrition value of several million tonnes of animal dung is burned for fuel purposes in every year, which ultimately leads impoverishment of social and a possible

reduction in crop yield. Bio-energy which includes forestry bio-mass, agricultural wastes and domestic wastes promises a reliable and permanent source of energy for developing countries. The development of bio-energy will help in reducing dependence on imported fossil energy and help in improvement of the environmental habitate. Bio-mass gasification is emerging as a realistic alternative to petroleum fuels. It is a process in which solid fuels are broken down using heat to produce combustible gas.

Bio-gas technology is based on the phenomenon of anaerobic decomposition of organic material resulting in methane production which serves not only as fuel for cooking, lighting, propelling engines, etc. but also the residual organic matter as a rich manure containing plant nutrients in a concentrated forms. Bio-gas plants fermenting dung and plant residues to produce gas for cooking, heating and other purposes along with fertilizer have much potential value for rural India. It is estimated that the energy efficiency of animal dung cakes is 11 per cent compared to 60 per cent for bio-gas. The bio-gas technique involves the bacterial fermentation of animal dung and other organic wastes in the absence of oxygen to yield a mixture of about 45 per cent carbon dioxide and 55 per cent methane which is used for cooking and lighting purposes. For running engine, the quantity of gas available must be sufficient. On an average 425 litres of gas is required per horse

power per hour. Water pumps or generators can be connected to the engine. The bio-gas scheme, which aims at maximum exploitation of the abundantly available animal, human and other wastes for production of cheap clean fuel and fertilizer, devoid the problem of pollution so as to meet most of the energy demand of rural areas, can in a way provides a solution of the fuel to great extent. If the entire 950 million tonnes of cattle dung available every year in our country is put through gobar gas plants, it may provide fuel gas for domestic need for 437 million people in addition to producing about 380 million tonnes of organic manure rich in nitrogen and humus. Against this potential, the Sixth Plan envisaged setting up of one million family size bio-gas plants and 1250 community plants.

Livestocks traditionally are of an abiding value to the rural economy in India. The cattle wealth of India is so stupendous that it can be turned to several uses of economic in nature. Bio-gas is considered as one of the most feasible and low cost form of non-conventional rural energy source in India where nearly 69200 million m^3 of gas can be produced annually from the livestock excreta which is equivalent to 88.8 billion kwh of electrical energy. The problem of cooking energy is of far greater concern to women, expecially poor women than the men. A poor woman has low access to cooking fuel, spends the largest time obtaining it, and put it to end

use which are not only fuel inefficiency, but which also subject her to serious diseases. Cooking energy also increasingly determines a woman's nutrition level. The most wide spread traditional cooking method in rural areas is open fire on traditional chullhas, about 10 per cent of the potential energy in the wood fuel is utilized. Apart from the enrrgy waste, open fire cooking system also causes harmful problems. It has been estimated that over 100 million women in our country spend a quarter of their lives in a gloomy kitchen. There are serious economic and environmental losses associated with the traditional pattern of the use of wood, crop residues and dung as fuel. Several studies in this context have revealed that the health hazards faced by women using firewood or dung fuels on traditional oven (chullhas) are of a serious nature. Bio-gas units therefore, remove the health hazards and help to prevent the spread of parasitic and microbial diseases also. The rapid increase in energy consumption is speedily depliting nature, conventional sources of fossil fuel, search for alternative sources of energy, has, therefore, to be intensified. The Non-Conventional Sources of Renewable Energy Department has been set-up for creating awareness among the masses about the non-conventional sources of renewable energy through demonstration, display and extension of education programmes relating to solar energy, bio-energy, wind energy, tidal energy, energy conservation and micro-bydel energy etc.

The KVIC's gobar gas scheme has pioneered the productive use of organic waste in the country-side with the twin advantages of supply of enrich manure which is essential to soil and supply of alternate source of energy. Installation of a gobar gas plant give three direct benefits to the owner. Firstly, smokeless cooking and lighting gas, secondly, nitrogenous rich manure and thirdly, reduction in health hazards as a slurry reduces the insects infestation. The gobar gas plant comprises a digester to ferment in an efficient manner the animal dung, urine and night soil. The gas holder covers this digester to collect and divert the gas produced through fermentation into the gas pipe at correct pressure. The gas pipe conveys the gas from the gas holder to the points of the use, i.e. kitchen stove, gobar gas lamps and gas engines without undue loss of pressure.

It has been observed that usually people are prone to confusion by the term like gobar gas or bio-gas. The plants constructed through Khadi and Village Industries Boards are known as gobar-gas plants whereas plants constructed through other agencies are bio-gas plants. In fact there is a little difference between these two system is that the gobar gas plant is one which uses cattle dung as feed stock, where as in bio-gas plant all types of biological wastes including animal dung as feed stock. Both the plants serve the same objective. At present, there are two basic designs of bio-gas (gobar gas) plant in India, namely; the KVIC model (floating drum type) and the Janta model (fixed dome type). However, several non-Governmental agencies are involved in

modigying the designs so as manufacturing cost may be reduced.

In 1973, the Government launched an "All India Coordinated Bio-gas Project to install 50,000 bio-gas plants in villages by 1978. The number of gas plants set up rose sharply from 6858 in 1973-74 to 80113 in 1979-80. The production of gas and manure registered an appreciable increase from 116.40 lakh cubic metres valued at Rs.30.80 lakhs and 0.86Lakh tonnes valued at Rs.26.28 lakhs to 1676.46 lakh cubic meters worth Rs.1247.04 lakhs and 17.09 lakh tonnes worth Rs.854.28 lakhs respectively. Since the launching of the National Project for Bio-gas Development (NPBD) in 1981-82, the development of bio-gas technology has received a new impetus in India. During 1981-82, the number of bio-gas plants set up was 25369 against the target of 35000 where as nearly 57500 bio-gas plants were installed during 1982-83. As against the annual target of 75000 plants for 1983-84, under the National Project on Bio-gas Development, 92582 plants have been set-up in different states. Of the total target of 75000 bio-gas plants for 1983-84 50000 were to be installed by State Governments and their agencies and the remaining 25000 by KVIC. The State Governments installed 76582 bio-gas units and KVIC installed 16000 units against these targets. The National Project for Bio-Gas Development programme has been accorded a very high priority and as such has been included under 20-point programme. There are more than 275000 bio-gas plants in India at

the moment. During seventh Five Year Plan, a new thrust has been given to this programme. Many additional facilities like establishment for repairing units at regional level of different states, provision for repair of defective bio-gas plants and training programmes have been added and extended. Quantum and rates of central subsidy, turn-key job- free, promotional incentive to village functionaries etc.have been increased considerably expecially in the backward areas of the country to eliminate the pressure on forests;to maintain the ecological and environmental sanitation and to increase agricultural production. A different rate of subsidy is considered desirable in order to encourage the installation of plants in backward areas of the country where due to cost factor, the response of beneficiaries has not been very encouraging.

The Government is giving subsidy and loan to the households for installation of bio-gas to proliferate this programme, because the utilization of bio-gas plants is almost pollution free. Its use can play an important part in reducing the deterimental health effects and it is renewable source of energy on the other. Though efforts have been made by Government as well as non-government organisations to promote the bio-gas technology on wider coverage of its expansion programme, still the technology is not so popular in Indian villages and the expansion programme is being adopted on an experiment basis by the rural households.

The past experience of its performance is not satisfactory and it seems that the bio-gas technology is in its introductory stage and there is a minimal awareness among the public about the system.

Lack of required cattle heads and the meagre financial resources of small and marginal farmers and landless people in rural areas are the critical factors. In spite of apparent need of renewable sources of energy and efforts made to reduce the cost of bio-gas plants, the technology continues to remain beyond the means of most rural households. The main difficulty in promoting the bio-gas technology on a large scale, the households of small and landless cannot affort because they have less cattle heads. An alternative to this problem is the introduction of the Community Bio-Gas Plants (CBPs) which envisages manifold promise to the rural folk having minimum capacity of 45 m^3/ day and meeting the fuel needs of at least 25 families. The Community bio-gas programme in India is at the moment in its initial stage. The first pilot Community Bio-gas Plant project, consisting of two interlinked plants of 45 cm^3 and 35 cm^3 capacity was initiated at Fateh Singh Ka Purva in Etawah (U.P) in March 1979 which fulfills the different requirement of 27 families. The Department of Non-Conventional Energy Sources, Ministry of Energy, Government of India, has initiated a programme of setting up of experimental and demonstration CBPs in the country under NPBD. The Scheme

of All India Coordinated Bio-gas Project, wholly financed by Government of India has demonstrated successfully the techniques of construction and operation of large size fixed dome community bio-gas plants. However, in India socio-cultural pattern, the community bio-gas system suffers from social and economic problems. Collection of dung, distribution of gas, operating expenses and repairing of plants are the main problems in the development of the community bio-gas programme. If the community gas plant is run by a selective body and the consumers are charged for gas connections (in case those who do not contribute in terms of dung and operational expenses) the problems like rate of charges, capacity to pay and keeping the records arise. Some of the problems can be removed by motivating and educating the users.

Bio-gas technology in India needs sufficient and systematic extension techniques for popularising. The mass media channels, viz. radio, television, record player, news paper, literature, pamplet, exhibition, etc. can definitely play a prominant role in motivating and educating people in conservative drives. Demonstration of gas plants and screening of films to educate the rural people about the benefits of gobar gas plants and display of posters and hoarding on roads can boost up the programme to a great extent. Whenever the new technological development or new device is introduced to the society, there are many factors that influence the rate of

acceptance and the wide use of the technology or device by society. In the case of bio-gas technology, some of the reasons are found for non-adoption or low adoption, such as high cost of plants, corrosion of steel gas holders, high maintenance and repair cost, low gas production during winter and dependence of the households on skill from outside.

Availability of water for preparation of slurry is also a major factor in the expansion of this programme. Water being a crucial input, plays a significant role in this regard. It is observed that most of the villages suffer from scarcity of water during summer, consequently the owners of the bio-gas plants unable to make slurry. In some cases, the owners of the plants have to depend on the mechanics who live generally in urban areas, even for the minor functional defects. Therefore, it will be very useful to give training to the villagers about the basic technical knowledge of bio-gas system.

At present most of the bio-gas plants in our country are fed with dung only. Due to some cultural constraints as well as dearth of knowledge, people do not use human waste, night soil from pigs and poultry which is very rich in producing methane gas. Waste of bio-mass can also be added in slurry for this purposes. In this reference most of the

people are not aware of other useful feeding materials for bio-gas plants. Many bio-gas plants in the rural areas are out of order due to small technical defects and these defects lead to discourage the extension bio-gas programme. The people in rural areas are more prone to confusion with a little incident related to technical defect. Introduction of low cost bio-gas plants will definitely attract the poor households. Chinese bio-gas system demonstrates the advantages of bio-gas plants to low income rural people. Installation of bio-gas plants alone will not slove the purpose of the programme but the provision of repair and maintenance is more important in popularising the bio-gas programme in our country. Provision of adequate research and development is one of the requirements for the development of bio-gas technology. Suitab le technology can be introduced and developed for different climatical zones.
